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ABSTRACT

Video-analysis was used to investigate the transition from coacting to alternating patterns of infant-mother vocalizations in this longitudinal study of one infant. In addition to investigating the transition and its developmental implications, the relationship between the temporal patterning of kinesic and vocal behaviors was studied. The study began when the infant was 3 and 1/2 months of age and ended when the child was 13 and 1/2 months old. A 3/4 inch color television camera was employed to tape a routine cycle of activity, usually on a bi-monthly basis. Each session taped was divided into feeding and play periods. Coaction was operationalized as the occurrence, within each session, of overlapping infant-mother vocalizations. Alternation was operationalized as infant vocalization(s) occurring between the offset of the mother's initial vocalization and the onset of her next vocalization without overlap with her infant's vocalization(s). The infant's state of arousal was also assessed. A test-retest reliability check of an observer's and a graduate student's ratings of coaction and alternation indicated correlations of .79 and .99 respectively. Transition to alternation occurred when the infant was approximately between 4 and 4 and 1/2 months of age and progressed developmentally. Results are discussed in relationship to the temporal requirements of turn-taking and rhythmic aspects of adult conversation. (Author/RH)

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Infant Mother Vocalization Patterns in Transition

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Abstract

Recent research has not examined the transition from coacting to alternating patterns of infant-mother vocalizations. The present longitudinal study investigated, using video analysis, this transition in a 3 1/2 to 13 1/2 month old infant. Transition to alternation occurred approximately between 4 and 4 1/2 months and progressed developmentally. This developmental pattern of alternating vocalization patterns is discussed in relation to the temporal requirements (i.e., turn-taking and rhythmic aspects of adult conversation.

In a ground breaking study on infant-mother vocalization patterns, Stern, Jaffe, Beebe, and Bennett (1975) found that mothers and their 3-4 month old infants have two structurally different modes of vocalizing with each other. The predominant mode, coaction, consisted of the simultaneous vocalizations of the infant mother pair and was generally found to be associated with high levels of arousal. The second mode, alternation, was characterized by nonoverlapping patterns of turntaking vocalizations between the infant-mother pair and was generally found to concentrate at moderate levels of arousal. Both patterns emerged in the data even though coaction concentrated around affective states while alternation predominated during social play.

Building upon this initial work of Stern et al, Beebe, Stern, and Jaffe (1978) reported evidence indicating a similar pattern of coaction and alternation in the temporal patterning of kinesic behaviors. Beebe et al contended this similar distinction between coaction and noncoaction in the kinesic realm suggests that the temporal patterning of activities is more important than the actual modality of stimulation. Some evidence was collected indicating the differential temporal organization of behavior during coactive and noncoactive episodes. For instance, during coactive sequences both mother and infant elongated their onset times, matched onset perfectly, and the mother tended to match her infant's durations. In noncoactive sequences, infant and mother generally tended to match their kinesic rhythms in "behavior pause cycles." Beebe et al concluded: 1) rhythmic expectancies were apparent in both modes, 2) rhythmic matching may conceivably presage the matching found in adult conversation, and 3) their findings provide additional support for the similar vocal and kinesic behavior in protoconversation.

Jaffe and Anderson (1978) have recently responded to these findings by claiming conversation grows ontogenetically out of the rhythmic alternation

of behaviors between the mother and her infant. Switching pauses in nonco-active episodes are thought to be analogous to switching pauses in adult conversation. Interestingly, this interpretation is compatible with the recent work by Bruner (1975) and his group on the interactional antecedants of language acquisition. Bruner contends what may be innate about language acquisition is not linguistic ability per se but some special features of human action which permits language to be decoded. In other words, knowledge of the requirements of action may help us crack the linguistic code. Bruner believes this may be most evident in the isomorphism between the linguistic form and the nature of human attention processing and in the hypothesized correspondence between linguistic case structure and the organization of action.

Other areas of research also appear to be relevant to the study of infant mother vocalization patterns and their possible preparatory function, in terms of their rhythmic structure, for later language acquisition. For instance, Wolff (1967, 1968a, 1968b, 1968c) contends the sucking behavior of the neonate is controlled by an endogenous microrhythm arising in the central nervous system. Ashton (1976) believes an internal pacemaker may develop out of early rhythmic systems in the neonate and later function as the basis for the temporal patterning of the person's motor skills. Scaiffe (1979) has similarly argued that innate rhythmic patterns may structure the infant's interactions in both time and space. Lastly, Piaget (1954) has discussed the prevalence of circular reactions, i.e., repetitive patterns for their own sake, during the early substages of sensorimotor development. The secondary circular reactions of the four month old infant (which do not center on the infant's body) appear to be at least conceptually similar to the current description of alternating vocalization patterns in the infant-mother pair and may provide the behavioral basis for the development of schema facilitating later

concept formation and language acquisition.

While the extant research on early coactive and noncoactive patterns between the infant-mother pair appears to be compatible with those cited studies dealing with the endogenous, interactional, and cognitive aspects of early infant development and to require little further explanation, a number of difficulties in this area have not as yet been adequately addressed. First, no research to date has examined the transition of infant-mother vocalizations from the initial and predominant pattern of coaction to that of alternation nor has the possibility of a developmental trend in alternating vocalization patterns been investigated. Stern et al only identified two structurally distinct modes of vocalizing in the three to four month old infant and hypothesized the likelihood of a developmental trend in alternating vocalizations. Obviously, an understanding of the transition to and development of alternating vocalization patterns would contribute to our knowledge of the early structure of interaction in terms of its sequencing, timing, and structural components. Second, both the findings of Stern et al and Beebe et al indicated kinesic and vocal patterns of coaction and noncoaction but neither elucidated the relation between these two modalities. Do coaction and noncoaction emerge concurrently in the kinesic and vocal realms? Does the temporal patterning of kinesic behaviors precede and/or elicit the temporal patterning of vocal behaviors? Do infants alternate kinesically with a vocalizing mother before they vocalize in alternation with her? None of these issues have been dealt with to date.

The purpose of the present study was thus to initiate a series of investigations to address the first of these issues within the context of our existing knowledge of early infant-mother alternations. Specifically, the pre-

sent study was designed to use detailed examination of film and video records to investigate the developmental trend of alternating vocalization patterns across the first year of the infant's life.

Methods

One normal male infant was observed from approximately 3 1/2 to 13 1/2 months of life. The mother was white and middle class and the father was Japanese-American. One camera monitored the course of the interaction over the ten month period of the study.

A 3/4 inch color video was employed (a Panasonic color T.V. camera, NV-3700) to tape a routine cycle of activity, on a bi-monthly basis (except for the session reported as session 4 which occurred approximately 2 1/2 months after session 3 and for session 10 which occurred approximately 4 months after session 9), of infant-mother interaction. Video taping began in late November and ended in early September of the following year. Each session was divided into feeding and play periods. All recording segments of play for each session began exactly three minutes after cessation of feeding and continued for an average of 8.53 minutes, sd=2.37.

The video tapes were replayed in the laboratory on a Video Cassette Recording System (Model #CP-5200/Player) and viewed by one trained observer on a SONY T.V. set. An Esterline Angus Operation Recorder (Trans Type), with electric pens that were operated by finger switches, was used to score the occurrence of all infant and all mother vocalizations. One trained graduate student recorded all infant and mother vocalizations on two alternate occasions and except for tape #10 the order of the tapes was randomly selected for coding. A test-retest reliability check for the ratings of coaction (at Time 1 and Time 2) and alternation (at Time 1 and Time 2) indicated correlations of .79 and .99 respectively.

The comparison of the infant's and mother's vocalizations constituted the raw data in the present study. Coaction was operationalized as the occurrence, within each session, of overlapping infant-mother vocalizations. Alternation was operationalized as infant vocalization(s) occurring between the offset of the mother's initial vocalization and the onset of her next vocalization without overlap with her infant's vocalization(s) (using the infant's offset to onset times produced the same number of alternations). A mean alternation score and a mean coaction score were computed for the two rating times. Additionally, a ratio of mean scores, i.e., the mean number of alternations for each session in relation to the mean total number of alternations and coactions in each session, was computed. Thus the two dependent variables in the present study were the mean number of alternations per session and the mean ratio scores per session (ratio of alternation vocalizations to total vocalization).

The present study also employed an infant-mother observation manual (Anderson, Vietze, Faulstich, and Ashe, 1978) to assess the infant's state of arousal. Five infant arousal states were coded: light sleep, drowsy, alert, fussy and fidgeting, and crying (see Anderson et al for a detailed description of the coding procedures). The same Esterline Recorder was used to record the infant-mother pattern of vocalizations. And the same independent rater was used to record the infant's state of arousal at Times 1 and 2. The test-retest rater reliabilities for four arousal scores (drowsy, alert, fussy and crying) were: 1.00, .97, .82, .99, respectively; there were no occurrences of light sleep.

Results

Alternation emerged as the predominant vocalization pattern at approximately 4 1/2 months of life for the young infant. Table 1 shows this rapid transition to alternation and the developmental trend in vocalizations across the ten recorded sessions for the ratio of the mean number of alternations to the total mean number of alternations and coactions during each session for the infant mother pair. It is evident that the actual proportion of coacting vocalizations

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Insert Figure 1 about here

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sharply declined between the first and third sessions (3 1/2 and 4 1/2 months respectively) and that the proportion of alternations remained thereafter relatively stable. The rapid emergence of alternation in the third session, preceded by two early sessions characterized by largely coacting vocalizations patterns, signifies the accomplishment of the transition to alternation in this infant-mother pair.

A series of standard regression analyses were computed in order to examine the developmental trend of alternations in relation to the overall pattern of vocalizations across sessions. Sessions, the developmental factor in the present study, was found to explain 64% of the variance of the ratio scores, $F=13.99$, $p < .001$. Subsequent analyses indicated only marginal incremental increases in R^2, with the Sessions factor included in the standard regression equation, for the following variables: length of record, mean=8.53 minutes, sd=2.37 (2%); and length of record in combination with the interaction of length of record and sessions (12.3%). However, while the effects of the above added variables were indeed

minimal, a significant quadratic effect for Sessions was found ($F=19.22$, $p < .001$) and increased the explained variance by 21% ($R^2=.85$) over that explained by Sessions alone.

A log transformation of the ratio scores, intended to maximize the linear form of the relationship, produced basically the same pattern of results (Sessions, $F=11.00$, $p < .01$, $R^2=.58$) and further indicated a substantial increase in the explained variance by adding the quadratic function of Sessions to the standard regression equation (the incremental change in R^2 was 27%, $F=19.37$, $R^2=.85$, $p < .001$). These ratio score findings indicate the general explanatory power of the developmental factor, Sessions and its quadratic function, to account for the disproportionate number of alternating vocalizations across the ten sessions of the study. Moreover, this pattern of results, i.e., a dramatic asymptote followed by a gradual two peaked increased in alternation, demonstrates the stabilization of two structurally distinct modes of vocalization within the first year of this infant's life.

An identical series of standard regression analyses were then computed to assess the effect of Sessions across the approximately ten month period of the study upon the mean number of alternations between the infant-mother pair in each session (a score averaged across the two time ratings). The effects of length of record, length of record in combination with the interaction of Sessions and length of record, and the trend functions of Sessions (quadratic and cubic) were controlled by inclusion within the regression equation. The results of this analysis of systematically entered factors, while indicating the Sessions factor explained 64% of the variance of the obtained alternation pattern ($F=14.41$, $p < .001$), also indicated a slightly different pattern for the alternation scores, compared to the ratio scores. Only length of record was found to contribute to the ex-

plained variance (increased R^2 by 20%) when included with Sessions in the standard regression equation, $F=19.00$, $R^2=.84$, $p < .001$. Thus for the alternation scores, the quadratic function of the Sessions factor was almost nonexistent and was significantly overridden in importance by the actual length of record for the various recorded sessions. A log transformation of the alternation scores, however, indicated an even stronger effect for the Sessions factor ($F=25.02$, $R^2=.76$, $p < .001$) and with length of record included in the regression equation could only increase the explained variance by roughly 9% ($R^2=.85$).

Since the actual length of record (which slightly varied across sessions) was found to increase the explained variance of actual alternation scores, but not the same scores transformed or the ratio scores, a series of partial correlation analyses were conducted to further assess the strength of the relationship between Sessions and alternation. Using log transformed data to maximize the linear form of the data, the Sessions factors (zero order $r=.87$, $p < .001$) was found to maintain the strongest relation with alternation when partialling out for the effects of: 1) length of record and the total number of vocalizations per session, second order partial $r=.83$, $p < .005$; and 2) length of record, number of vocalizations, and alertness, third order partial $r=.79$, $p < .018$. Thus the strength of the relationship between Sessions and alternation was nearly unaffected when controlling for the above factors (the only variables found to significantly correlate with alternation). These results clearly indicate, in combination with the systematically entered variables in the regression analyses, the overwhelming strength of the Sessions factor to explicate the infant-mother alternation pattern across the approximately ten month period of the study.

An analysis of the coded arousal level scores was computed. While none of

of the arousal levels were found to be related to the coaction vocalizations of the infant-mother pair (all p's $>.15$), and even when the highest arousal scores of fussiness and crying were collapsed and combined ($p<.8$), it was found that alertness (mean=8.05 minutes, sd=2.50) and fussiness (mean=.22 minutes, sd=.3) could explain 68% of the variance of the alternation scores in a standard regression equation, $F=7.31$, $p<.02$. Although the majority of the explained variance was accounted for by the generally alert state of the infant during the infant-mother alternations, it is also evident that the relationship between alertness and alternation was essentially spurious; with log transformed data, the first order partial r between Sessions and alternation when controlling for alertness was .86, $p<.001$ (zero order r=.87) and the second order partial r when controlling for alertness and fussiness was .84, $p<.004$. Whereas the first order partial r between alertness and alternation was reduced from a zero order r of .63, $p<.025$, to .10, p=.41, when controlling for the effects of Session and length of record.

A final set of analyses were calculated to control statistically for an unintended change in the circumstances of the study. On session 3, the infant mother pair was relocated from an office setting to a laboratory setting. The subsequent analyses were computed to control for the change in situation and to assess the extent to which the change in situations may have contributed to the dramatic burst in the proportion of alternations from session 2 to session 3. Since a common data set was desired and the actual length of record varied across the three early sessions, the first six minutes of each session were examined. Each six minute session was divided into six one minute segments. This permitted the assessment of the pattern of response across segments and in relation to the change in the situation. The Segments factor was found to significantly predict the alternation scores ($F=4.11$, $p<.05$) and to explain 20% of the variance.

Adding the situation factor to the standard regression equation only increased the explained variance by 8% and was only marginally significant, $F=2.97$, $p < .08$. Figure 2 shows the pattern of alternating vocalizations across the

Insert Figure 2 about here

six segments for each of the three early sessions. An inspection of the graphs of Figure 2 and the preceding findings indicate alternation generally emerged toward the end of each session as the interaction between the infant mother pair unfolded. Yet the marginally significant effect for the situation factor, and its slight addition of explained variance (8%), suggests while the change in situation cannot account for the dramatic burst in alternation it may have nonetheless helped the actual transition to alternation along.

Discussion

The present study demonstrated, consistent with previous research on coaction and alternation (Stern et al and Beebe et al), the occurrence of two structurally distinct modes of vocalization in the infant-mother pair, alternation and coaction. Furthermore, as suggested by Stern et al, both modes were found to change developmentally over the course of the 10 month study. The initial predominance of vocal coactions rapidly diminished between the infant's fourth and 4.5 month of life while alternation became the increasingly dominant mode of vocalization. Alternation was thus found to progress developmentally across the ten month period of the study so that by the last recording session (month number 13 1/2) 84% of the infant's vocalizations were occurring within the alternation mode. This rapid transition to and highly systematic development of alternation as a proportion of total vocalization was found to be, when having controlled for all other related factors, largely attributable to the infant's

age/level of development and its quadratic function. Contrary to the early Stern et al findings, high arousal states were not found to be significantly associated with coaction and moderate levels of arousal were not significantly associated with alternation when controlling for Sessions and the length of record.

Unfortunately, the present study did not include a sufficient number of measures, i.e., in terms of onset to offset times, the matching of durations and/or measures of rhythmic pauses, by which the actual rhythmicity of the infant-mother interactions could be more accurately assessed. However, a visual inspection of the video tapes makes apparent, and consistent with the Beebe et al findings, that the pattern of infant-mother vocalizations became more finely tuned to one another over the ten month period of the study. Both infant and mother became extremely sensitive to each other's verbal and nonverbal behaviors (Bruner, 1978). This fine tuning of behaviors appears to be just one component of the emerging rhythmicity between the mother and her infant and to generally reflect the manner in which the infant-mother pair organize their behaviors around one another to insure a high degree of coordinated social interchange (Cairns, 1979). The coordinated behaviors of the infant-mother pair literally permitted rounds of social interaction. It is as if reciprocal social interchanges were the larger social context of meanings within which alternations were embedded and developed.

Related to the coordination of infant-mother behaviors appear to be the increasing ability of the infant to organize and integrate alternations into it's own developing behavioral repertoire. By the eighth session, the infant had become much more exploratory and active than in earlier sessions and had increasingly learned to integrate alternating vocalizations with a growing number of new behaviors. Thus an increasing complexity of behaviors had emerged

whereby the infant was beginning to combine gestures, postures, positions, glances, and expressions with his alternating vocalizations. The infant became more and more social and cognitive in this regard. Moreover, a visual inspection of the data suggested the infant used his vocalizations to communicate intentionality (Richards, 1974), i.e., lift me up, hold me, bring the stool, or even "no", within the rhythmicity of alternating and coacting vocalizations.

Perhaps of greater importance, the present study provided further support for the temporal structure of conversation in the infant's early social interactions. The young infant appears to have been "prepared and even primed" for later adult conversation by virtue of the gross similarity between the temporal organization of its vocalizations (alternations) and the temporal requirements of adult conversation. In other words, early in life the infant learns to keep time and to take turns in his/her interactions with the caretaker(s), which may set the stage for the eventual learning of turn taking rules in adult conversation. Turn taking may function in this sense as part of an interactional precursor to the acquisition of the rhythmic aspects of later language acquisition. Infant-mother alternation may serve to establish the rudimentary foundation for many of the developing infant's later temporally patterned linguistic interactions.

Combining the results of the present study with those of Stern et al and Beebe et al suggests that coaction and alternation may constitute more than simply two structurally distinct modes of vocalization. The parallel findings in both kinesic and vocal realms, along with the systematic development of alternation within the larger context of socially integrated actions and meanings, suggests we may be discussing in fact two structurally distinct modes of social interaction. That is, early in life the young infant may acquire the basic and universal components of all social interaction, coaction and alternation. The infant subsequently learns with time and experience to express himself/herself differently in the two modes, i.e., kinesically, nonverbally, verbally, or in some combination.

It seems apparent that to the extent we are consciously interacting or deliberating with one another, we must engage ourselves in one or the other of these modes. Furthermore, to the extent we interact with imaginary others or audiences, i.e., in fantasy, meditation, or just in anticipation, we most likely assume both roles of ego and alter and proceed systematically on the basis of the rules of turn taking. The interactional modes of alternation and coaction may function when viewed in this manner, to provide the building blocks upon which meanings are constructed, role/rule frameworks are hammered out, episodic sequences are designed, and by which social actions unfold in real time.

In conclusion, the present study demonstrated in the infant-mother pair the transition to alternation and the developmental progression of alternating vocalizations. These findings were broadly discussed in relation to the temporal organization of adult conversation. Additionally, the present findings along with prior reports suggest the possibility that coaction and alternation may function as two basic and universal structural components of social interaction.

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Figure 1

The mean ratio scores for the infant-mother pair, derived from ratings for times 1 and 2 across the ten recorded sessions (the mean number of alternations per session in relation to the mean total number of alternations and coactions per session).

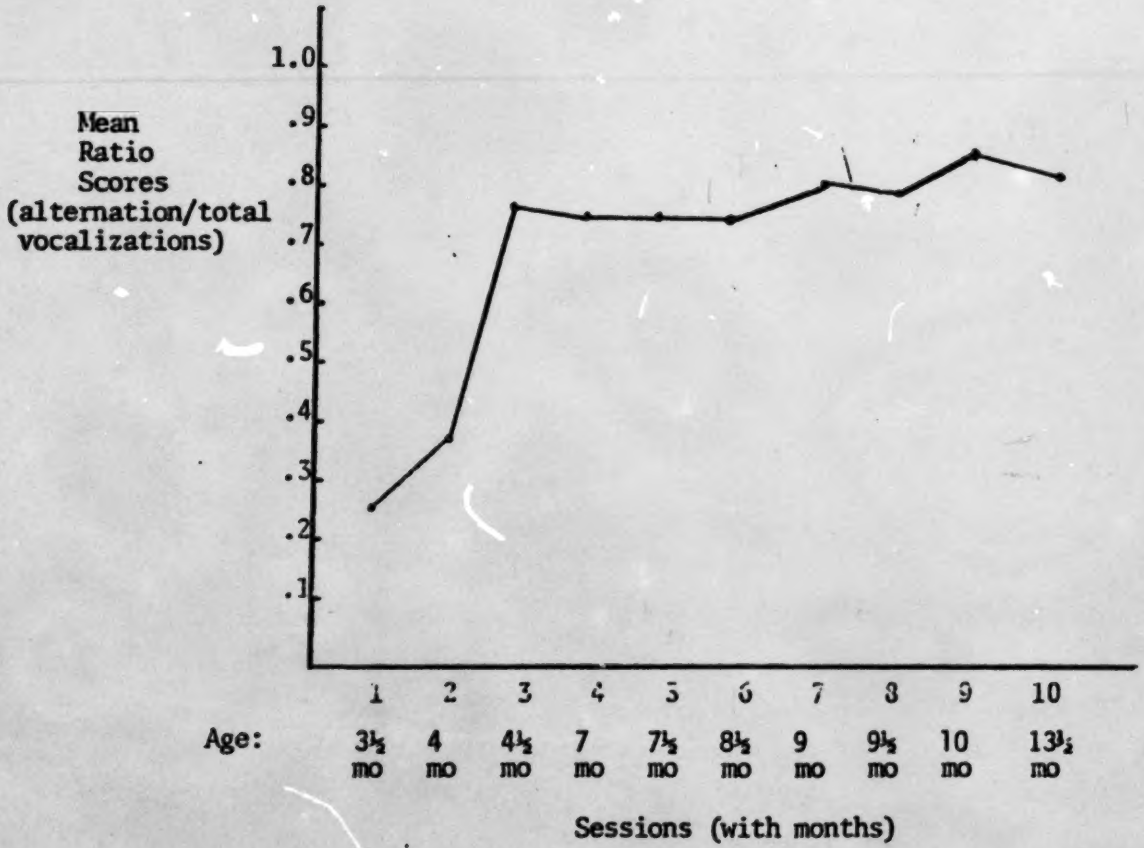
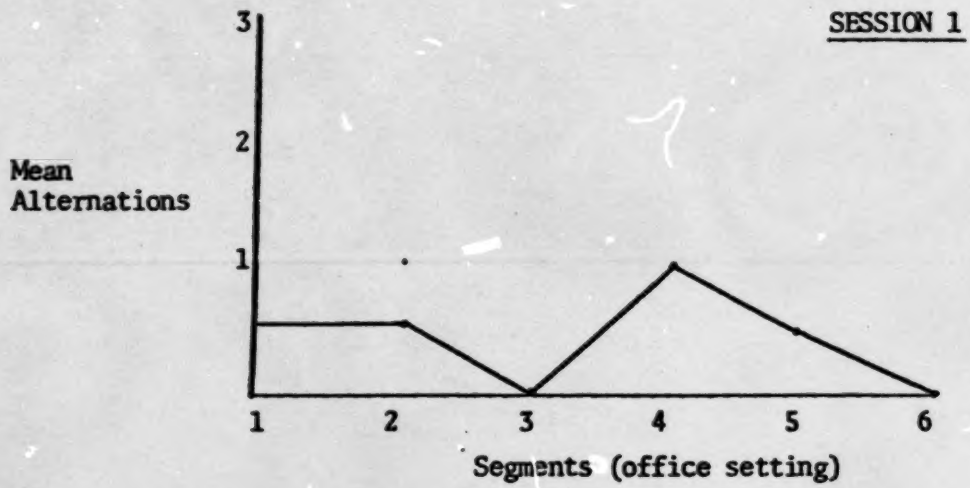
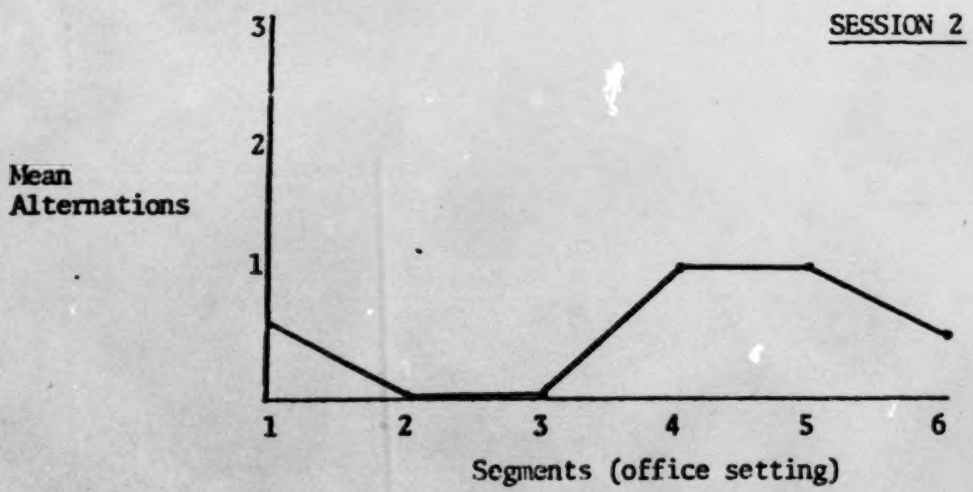
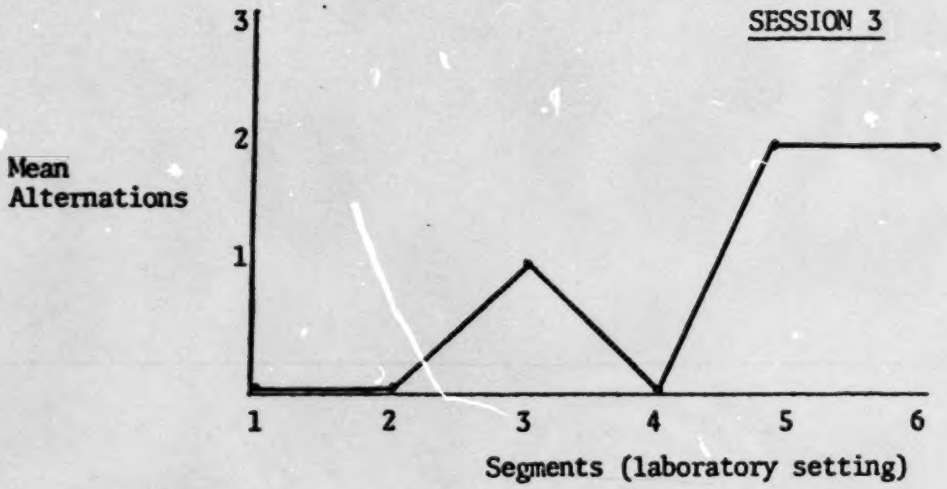


Figure 2

Mean number of alternations for times 1 and 2 across the six one minute segments for each of the first three sessions.






SESSION 3
Mean
Alternations
3
2
1
1
2
3
4
5
6
Segments (laboratory setting)